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MINERALOGY.—*A new classification of the sulfo-salt minerals.* EDGAR T. WHERRY and WILLIAM F. FOSHAG, National Museum.[1]

The data for this paper were collected while the senior author was employed in the National Museum; the junior author, his successor there, has aided in bringing them up to date. The plan followed is essentially the same as that recently applied to the sulfide minerals,[2] although formulas are stated in both expanded and condensed forms, to bring out relationships as fully as possible. The chief new features are: the systematic assignment of minerals to divisions based on the ratios of basic and acidic sulfides, and to groups based on crystallization; the classing of minerals containing both univalent and bivalent metals as double compounds rather than as isomorphous mixtures, and the throwing out of evident admixtures before calculating formulas from analyses; and the interpretation of certain instances of high sulfur content as due to a higher state of oxidation of the metal rather than the non-metal, resulting in the discarding of a "sulfarsenate-sulfantimonate" division, such as has usually been recognized heretofore.

[1] Published with the permission of the Secretary of the Smithsonian Institution. Received November 12, 1920.

[2] This JOURNAL 10: 487. 1920.

SULFO-SALTS: METALLIC SALTS OF SEMI-METAL SULFO-ACIDS (Also SELENO-ACIDS)

1 : 3 DIVISION			New.
VRBAITE GROUP. ORTHORHOMBIC			New.
Eichbergite	$Cu_2S : 3(Bi, Sb)_2S_3$	$Cu(Bi, Sb)_3S_5$	Crystallization and homogeneity uncertain.
Vrbaite	$Tl_2S : 3(As, Sb)_2S_3$	$Tl(As, Sb)_3S_5$	
1 : 2 DIVISION			Part of Dana's "Acidic division."
LIVINGSTONITE GROUP. CRYSTALLIZATION UNKNOWN			New.
Livingstonite	$HgS : 2Sb_2S_3$	$HgSb_4S_7$	Homogeneity uncertain, yet shows distinctive mineragraphic characters. Davy and Farnham, *Micr. exam. ore min.*, N. Y., 1920.
Chiviatite	$PbS : 2Bi_2S_3$	$PbBi_4S_7$	Often assigned a more complex formula, but after deducting impurities, the analyses agree with that adopted, the theory for which is: Pb 16.4, Bi 65.8, S 17.8%.
1 : 1.5 OR 2 : 3 DIVISION			Part of Dana's "Acidic division."
REZBANYITE GROUP. CRYSTALLIZATION UNKNOWN			New. "Histrixite," if homogeneous, belongs here.
Rezbanyite	$2PbS : 3Bi_2S_3$	$Pb_2Bi_6S_{11}$	Homogeneity uncertain, yet shows distinctive mineragraphic characters (D. & F.); corrected analyses agree with formula adopted; theory: Pb 20.6, Bi 61.9, S 17.5%.
1 : 1.17 OR 6 : 7 DIVISION			New.
CYLINDRITE GROUP. STRUCTURE CYLINDRICAL			New.
Cylindrite	$6PbS : 6SnS_2.Sb_2S_3$	$Pb_6Sn_6Sb_2S_{21}$	
1 : 1 DIVISION			Dana's "Meta-division."
TRECHMANNITE GROUP. HEXAGONAL-TRIGONAL-TETARTOHEDRAL			New.
Trechmannite	$Ag_2S : As_2S_3$	$AgAsS_2$	
Platynite	$PbS : Bi_2Se_3$	$PbBi_2SSe_3$	

CHALCOSTIBITE GROUP. ORTHORHOMBIC			Dana's "Zinkenite group."
Chalcostibite	$Cu_2S : Sb_2S_3$	$CuSbS_2$	Includes "guejarite" (Dana No. 110); compare Dana, App. I, p. 16.
Emplectite	$Cu_2S : Bi_2S_3$	$CuBiS_2$	Includes "cuprobismutite" (Dana No. 112), the analyses and properties of the two being essentially identical.
Andorite	$Ag_2S.2PbS : 3Sb_2S_3$	$AgPb(SbS_2)_3$	Homogeneity has been questioned, but the evidence for its definiteness seems adequate.
Hutchinsonite	$Tl_2S.PbS : 2As_2S_3$	$Tl_2Pb(AsS_2)_4$	The name sartorite, used by Dana, is later;
Scleroclasite	$PbS : As_2S_3$	$Pb(AsS_2)_2$	ending *ite* added for uniformity.
Zinkenite	$PbS : Sb_2S_3$	$Pb(SbS_2)_2$	Also spelled zinckenite.
MIARGYRITE GROUP. MONOCLINIC			Separated but not named by Dana.
Smithite	$Ag_2S : As_2S_3$	$AgAsS_2$	
Miargyrite	$Ag_2S : Sb_2S_3$	$AgSbS_2$	
Plenargyrite	$Ag_2S : Bi_2S_3$	$AgBiS_2$	
Lorandite	$Tl_2S : As_2S_3$	$TlAsS_2$	
GROUP OF UNKNOWN CRYSTALLIZATION			New.
Matildite	$Ag_2S : Bi_2S_3$	$AgBiS_2$	
Alaskaite	$Ag_2S.PbS : 2Bi_2S_3$	$Ag_2Pb(BiS_2)_4$	Homogeneity uncertain.
Galenobismutite	$PbS : Bi_2S_3$	$Pb(BiS_2)_2$	
Weibullite	$2PbS : Bi_2S_3.Bi_2Se_3$	$Pb_2Bi_4S_5Se_2$	
Berthierite	$FeS : Sb_2S_3$	$Fe(SbS_2)_2$	
1.25 : 1 OR 5 : 4 DIVISION			Part of Dana's "Intermediate division."
PLAGIONITE GROUP. MONOCLINIC			Separated but not named by Dana.
Liveingite	$5PbS : 4As_2S_3$	$Pb_5As_8S_{17}$	
Plagionite	$5PbS : 4Sb_2S_3$	$Pb_5Sb_8S_{17}$	
Bismutoplagionite	$5PbS : 4Bi_2S_3$	$Pb_5Bi_8S_{17}$	Crystallization possibly orthorhombic.
1.33 : 1 OR 4 : 3 DIVISION			New.
BAUMHAUERITE GROUP. MONOCLINIC			New.
Baumhauerite	$4PbS : 3As_2S_3$	$Pb_4As_6S_{13}$	

1.5 : 1 OR 3 : 2 DIVISION			Part of Dana's "Intermediate division."
KLAPROTHOLITE GROUP. ORTHORHOMBIC			Separated but not named by Dana.
Klaprotholite	$3Cu_2S : 2Bi_2S_3$	$Cu_6Bi_4S_9$	
Schirmerite	$2Ag_2S.PbS : 2Bi_2S_3$	$Ag_4PbBi_4S_9$	Crystallization and homogeneity uncertain.
Rathite	$3PbS : 2As_2S_3$	$Pb_3As_4S_9$	
1.67 : 1 OR 5 : 3 DIVISION			New.
JAMESONITE GROUP. ORTHORHOMBIC OR MONOCLINIC			New.
Jamesonite	$4PbS.FeS : 3Sb_2S_3$	$Pb_4FeSb_6S_{14}$	Includes "warrenite" (Dana No. 126); the old formulas, $3PbS.2Sb_2S_3$ and $2PbS.Sb_2S_3$, have been discredited; Schaller's formula is adopted.
Franckeite	$5PbS : 2SnS_2.Sb_2S_3$	$Pb_5Sn_2Sb_2S_{12}$	Includes "plumbostannite."
1.75 : 1 OR 7 : 4 DIVISION			New, may belong with preceding.
HETEROMORPHITE GROUP. MONOCLINIC			New.
Heteromorphite	$7PbS : 4Sb_2S_3$	$Pb_7Sb_8S_{19}$	Pisani's formula is adopted.
2 : 1 DIVISION			Part of Dana's "Intermediate division."
DUFRENOYSITE GROUP. ORTHORHOMBIC			Dana's "Jamesonite group."
Silver-jamesonite	$2Ag_2S.8PbS : 5Sb_2S_3$	$Ag_4Pb_8(Sb_2S_3)_5$	Shannon, *Proc. U. S. Nat. Mus.* **58**: 601. 1920.
Dufrenoysite	$2PbS : As_2S_3$	$Pb_2As_2S_5$	
Plumosite	$2PbS : Sb_2S_3$	$Pb_2Sb_2S_5$	
Cosalite	$2PbS : Bi_2S_3$	$Pb_2Bi_2S_5$	Includes "kobellite" (Dana No. 131), which is an isomorphous mixture of this and the preceding.
GROUP OF UNKNOWN CRYSTALLIZATION			New.
Brongniardite	$Ag_2S.PbS : Sb_2S_3$	$Ag_2PbSb_2S_5$	Described as isometric through error; homogeneity uncertain, yet shows distinctive mineragraphic characters (D. & F.)
Schapbachite	$Ag_2S.PbS : Bi_2S_3$	$Ag_2PbBi_2S_5$	Homogeneity uncertain.
2.25 : 1 OR 9 : 4 DIVISION			Part of Dana's "Intermediate division."
SEMSEYITE GROUP. MONOCLINIC			Separated but not named by Dana.
Semseyite	$9PbS : 4Sb_2S_3$	$Pb_9Sb_8S_{21}$	Spencer's simplest formula is adopted.

2.33 : 1 OR 7 : 3 DIVISION			Part of Dana's "Intermediate division."
DIAPHORITE GROUP. ORTHORHOMBIC			Separated but not named by Dana.
Diaphorite	$3Ag_2S.4PbS : 3Sb_2S_3$	$Ag_3Pb_2Sb_3S_8$	
FREIESLEBENITE GROUP. MONOCLINIC			Separated but not named by Dana.
Freieslebenite	$3Ag_2S.4PbS : 3Sb_2S_3$	$Ag_3Pb_3Sb_3S_8$	
2.5 : 1 OR 5 : 2 DIVISION			Part of Dana's "Intermediate division."
BOULANGERITE GROUP. CRYSTALLIZATION ORTHORHOMBIC			New.
Wittichenite	$5Cu_2S : 2Bi_2S_3$	$Cu_{10}Bi_4S_{11}$	After deducting impurities, analyses agree with formula adopted; theory: Cu 34.9, Bi 45.7, S 19.4%.
Boulangerite	$5PbS : 2Sb_2S_3$	$Pb_5Sb_4S_{11}$	The old formula, $3PbS : Sb_2S_3$, has been discredited, and Sjögren's is adopted; theory: Pb 55.4, Sb 25.7, S 18.9%.
3: 1 DIVISION			Dana's "Ortho-division."
PYRARGYRITE GROUP. HEXAGONAL-TRIGONAL-HEMIMORPHIC			
Proustite	$3Ag_2S : As_2S_3$	Ag_3AsS_3	
Pyrargyrite	$3Ag_2S : Sb_2S_3$	Ag_3SbS_3	
BOURNONITE GROUP. ORTHORHOMBIC			
Seligmannite	$Cu_2S.2PbS : As_2S_3$	$CuPbAsS_3$	
Bournonite	$Cu_2S.2PbS : Sb_2S_3$	$CuPbSbS_3$	
Aikinite	$Cu_2S.2PbS : Bi_2S_3$	$CuPbBiS_3$	
PYROSTILPNITE GROUP. MONOCLINIC			Separated but not named by Dana.
Stylotypite	$3Cu_2S : Sb_2S_3$	Cu_6SbS_5	Includes "falkenhaynite;" axial angle β near 90°, making it peri-rhombic.
Xanthoconite	$3Ag_2S : As_2S_3$	Ag_3AsS_3	
Pyrostilpnite	$3Ag_2S : Sb_2S_3$	Ag_3SbS_3	
Samsonite	$2Ag_2S.MnS : Sb_2S_3$	$Ag_4Mn(SbS_3)_2$	
GROUP OF UNKNOWN CRYSTALLIZATION			New. "Tapalpite" (Dana No. 143), which would fall in this group, is evidently a mixture.
Guitermanite	$3PbS : As_2S_3$	$Pb_3(AsS_3)_2$	Analyses agree with this simplified formula; theory: Pb 64.4, As 15.6, S 20.0%.

Embrithite	$3PbS : Sb_2S_3$	$Pb_3(SbS_3)_2$	Includes "epiboulangerite" (Dana No. 161); classed by Dana as a variety of boulangerite, although all dependable analyses show that mineral to have a different ratio (see above); some analyses suggest that a 3 : 1 compound may exist, although the homogeneity of the material is very doubtful; theory: Pb 58.9, Sb 22.8, S 18.3%.
Lillianite	$3PbS : Bi_2S_3$	$Pb_3(BiS_3)_2$	
3.5 : 1 OR 7 : 2 DIVISION			Part of Dana's "Basic division."
TETRAHEDRITE GROUP. ISOMETRIC-TETRAHEDRAL			The formula for this group adopted by Dana, $4R_2S : X_2S_3$, does not agree with the analyses, and Tschermak's is here adopted; the more complex formulas of Prior and Spencer and of Kretschmer do not appear to be justified by the evidence.
Tennantite	$5Cu_2S.2(Cu, Fe, Zn)S : 2As_2S_3$	$Cu_{10}(Cu, Fe, Zn)_2As_4S_{13}$	Includes "binnite" (Dana No. 123); theory: Cu 51.5, As 20.3, S 28.2%, with up to 7.6% Fe and Zn replacing Cu.
Tetrahedrite	$5Cu_2S.2(Cu, Fe, Zn)S : 2Sb_2S_3$	$Cu_{10}(Cu, Fe, Zn)_2Sb_4S_{13}$	Theory: Cu 46.0, Sb 28.9, S 25.1%, with up to 6.8% of Fe and Zn replacing Cu.
Schwatzite	$5Cu_2S.2(Cu, Hg)S : 2Sb_2S_3$	$Cu_{10}(Cu, Hg)_2Sb_4S_{13}$	May contain up to 17% Hg.
Freibergite	$5(Cu, Ag)_2S.2(Cu, Fe)S : 2Sb_2S_3$	$(Cu, Ag)_{10}(Cu, Fe)_2Sb_4S_{13}$	Several other varieties of tetrahedrite have been described, but most if not all appear to be mixtures.
LENGENBACHITE GROUP. TRICLINIC			New.
Lengenbachite	$Ag_2S.6PbS : 2As_2S_3$	$Ag_2Pb_6As_4S_{13}$	Hutchinson's formula is adopted.

4 : 1 DIVISION			Part of Dana's "Basic division."
ARGYRODITE GROUP. ISOMETRIC-TETRAHEDRAL			Separated but not named by Dana.
Argyrodite	$4Ag_2S : GeS_2$	Ag_8GeS_6	Penfield's formula is adopted.
Canfieldite	$4Ag_2S : SnS_2$	Ag_8SnS_6	Isomorphous mixtures of this and the preceding occur.
JORDANITE GROUP. ORTHORHOMBIC			Separated but not named by Dana.
Jordanite	$4PbS : As_2S_3$	$Pb_4As_2S_7$	
Meneghinite	$4PbS : Sb_2S_3$	$Pb_4Sb_2S_7$	
5 : 1 DIVISION			Part of Dana's "Basic division" and of his "Sulpharsenates....."
ENARGITE GROUP. ORTHORHOMBIC			
Enargite (part)	$Cu_2S.4CuS : As_2S_3$	Cu_3AsS_4	Often classed as a sulfarsenate, but its occurrence and associations suggest that its high sulfur content is due to the presence of cupric copper; analyses show wide variation, approaching luzonite (below).
Famatinite	$Cu_2S.4CuS : Sb_2S_3$	Cu_3SbS_4	Compare note on enargite; includes "goldfieldite," a variety containing admixed tellurium, etc.
STEPHANITE GROUP. ORTHORHOMBIC-HEMIMORPHIC			Separated but not named by Dana.
Stephanite	$5Ag_2S : Sb_2S_3$	Ag_5SbS_4	
Geocronite	$5PbS : Sb_2S_3$	$Pb_5(SbS_4)_2$	Includes "kilbrickenite" (Dana No. 154), the analyses and properties of the two being essentially identical.
GROUP OF UNKNOWN CRYSTALLIZATION			New.
Sulvanite	$Cu_2S.4CuS : V_2S_3$	Cu_3VS_4	Probably analogous to enargite.
6 : 1 DIVISION			Part of Dana's "Basic division" and part of his "Sulpharsenates...."
BEEGERITE GROUP. ISOMETRIC			Separated but not named by Dana.
Beegerite	$6PbS : Bi_2S_3$	$Pb_6Bi_2S_9$	Homogeneity uncertain, yet shows distinctive mineragraphic characters (D. & F.).

GROUP OF UNKNOWN CRYSTALLIZATION			New. "Richmondite," if homogeneous, would belong here.
Luzonite (part)	$6CuS : As_2S_3$	$Cu_6As_2S_9$	Some massive luzonite has been shown by minerographic study to be distinct from normal enargite, although other so-called luzonite is crystallographically identical therewith; theory: Cu 46.5, As 18.3, S 35.2%.
(High-sulfur famatinite)	$6CuS : Sb_2S_3$	$Cu_6Sb_2S_9$	Corresponds to preceding; theory: Cu 41.9, Sb 26.4, S 35.2%.
8 : 1 DIVISION			Part of Dana's "Basic division."
POLYBASITE GROUP. MONOCLINIC			Separated but not named by Dana.
Pearcite	$8Ag_2S : As_2S_3$	$Ag_{16}As_2S_{11}$	Van Horn and Cook's formula is adopted.
Polybasite	$8Ag_2S : Sb_2S_3$	$Ag_{16}Sb_2S_{11}$ *	Formula assumed to correspond to the preceding; agrees well with analyses; theory: Ag 74.4, Sb 10.4, S 15.2%.
9 : 1 DIVISION			Part of Dana's "Sulpharsenates...."
EPIGENITE GROUP. ORTHORHOMBIC			Separated but not named by Dana.
Epigenite	$3Cu_2S.9CuS.6FeS : 2As_2S_3$	$Cu_{18}Fe_6(AsS_3)_4$	Rammelsberg's formula is adopted.
12 : 1 DIVISION			Part of Dana's "Basic division."
POLYARGYRITE GROUP. ISOMETRIC			Separated but not named by Dana.
Polyargyrite	$12Ag_2S : Sb_2S_3$	$Ag_{24}Sb_2S_{15}$	

ANALYTICAL CHEMISTRY.—*Note on crucibles used in rock analysis.*[1] HENRY S. WASHINGTON, Geophysical Laboratory, Carnegie Institution of Washington.

It may be of interest to those who are engaged in the analysis of silicates or silicate rocks to put on record my experience with a palau and an iridium-platinum crucible, which have been used for the fusion of rock powders with sodium carbonate. Palau is an alloy, introduced a few years ago as a substitute for platinum, and is composed of 80 per cent gold and 20 per cent palladium. A small percentage of iridium is often alloyed with platinum to impart greater stiffness, as pure platinum is noticeably soft.[2]

It is well known to those analyzing rocks that, when platinum or iridium-platinum crucibles are used for the sodium carbonate fusion, the cold cake sometimes adheres obstinately to the crucible walls, after slight soaking with water in the crucible and gentle heating over a low flame, instead of freeing itself as it "should do." This behavior necessitates prolonged digestion of the adherent melt so as to dissolve the cake, which sometimes results in loss of substance, and always in loss of time.

This unfortunate behavior is caused, in many cases, by indentations or other irregularities in the crucible wall or bottom, brought about by careless handling, such as squeezing the crucible to loosen the cake. It is also apparently rendered more liable to happen through the ogee-like curve assumed by the lower parts of the sides of platinum crucibles after long usage; and is easily brought about by attempting to remove the cake before it is quite cold and before it has separated or has started to separate from the walls. The roughness of the inner surface of platinum crucibles is also a determining factor. Even if the

[1] Received November 15, 1920.

[2] For some studies on the quality and properties of various platinum wares on heating see: R. W. HALL, Journ. Amer. Chem. Soc. **22**: 494. 1900; HULETT and BERGER, Journ. Amer. Chem. Soc. **26**: 1512. 1904; HILLEBRAND, WALKER, and ALLEN, Journ. Ind. Eng. Chem. **3**: 686. 1911; BURGESS and SALE, Journ. Ind. Eng. Chem. **6**: 452. 1914; **7**: 561. 1916; Bull. Bur. Standards **12**: 289. 1915 (Sci. Paper **254**); BURGESS and WALTENBERG, Bull. Bur. Standards **13**: 365. 1916 (Sci. Paper **280**); HILLEBRAND, U. S. Geol. Survey Bull. **700**: 102 (Note 3). 1919.

cake as a whole separates from the walls, there is often left a narrow patch or series of patches around the upper edge of the cake, strongly adherent to the crucible wall, though this is of less consequence. I have frequently had the opportunity to observe this annoying occurrence, with both platinum and iridium-platinum crucibles, and have elsewhere called attention to it.[3]

In the course of making many rock analyses it was found that crucibles made of pure platinum (Heraeus) were very soft, and apparently not sufficiently polishable internally, so that a ready loosening of the cake from them was seldom accomplished; although for general ignition purposes they are admirable, because of the negligible loss of weight on ignition. Crucibles made of platinum alloyed with a small amount of iridium (such as were used in my laboratory from 1896 to 1912), were found to be much better for the carbonate fusion. They are stiffer than pure platinum, and are therefore less liable to indentation, and are also susceptible of a higher polish. The cake loosened more often and more readily than from pure platinum, but still adhered occasionally. In the spring of 1918 I began using a palau crucible, chiefly with the object of testing the material in actual rock analysis, because of the constantly augmenting cost of platinum. To my great gratification it was found that the cold sodium carbonate cake always separated easily, quickly, and almost or quite completely from the crucible, far better and more surely than it had done from either platinum or iridium-platinum crucibles of about the same size and shape. With this crucible, which is now reserved for this purpose, I have made many fusions with sodium carbonate, but have not once found the cake to adhere—in each case it has freed itself rapidly and completely, on gentle heating with enough water to cover it.

This satisfactory behavior is the more noteworthy because this crucible is slightly indented, at about the level of the upper edge of the melt, around the zone of contact with the supporting triangle.[4] Apparently the palau softens rather more than plati-

[3] H. S. WASHINGTON. *Manual of the chemical analysis of rocks* (New York, 1919), pp. 132 and 135.

[4] A triangle of fused silica or of pipe stems must be used with palau crucibles. Platinum triangles alloy with palau and ruin both crucible and triangle.

num or iridium-platinum on strong ignition. It is to be noted, by the way, that for my fusions the blast was never used. The heating was done for the most part over a half-high Bunsen burner flame, which is quite sufficient to fuse the carbonate mixture, and was usually supplemented by a Meker burner during the last fifteen minutes or so. The time of heating varied from forty-five minutes to one hour. About 1 gram of rock powder and 5 grams of sodium carbonate were used for each fusion.

The cause of this freedom from adhesion of the cake to the palau crucible walls is uncertain. I am inclined to attribute it chiefly, if not wholly, to the superior hardness and stiffness of the alloy, and especially to its superior polish. The iridium-platinum alloy is almost, but not quite, equal to palau in these respects, while pure platinum is much softer and susceptible of less polish. Whatever the cause may be, and whether the same behavior is true of palau crucibles in general, the observations mentioned indicate that palau is superior to iridium-platinum, and still more to pure platinum, for the purpose of the sodium carbonate fusion in rock analysis.

I have not tested the resistance of the palau crucible to fusion with potassium (or sodium) pyrosulfate, though some of the references given above indicate that it loses more weight during the operation than platinum or iridium-platinum.

It may, however, be of interest to give the data as to loss in weight of the palau crucible, as well as of an iridium-platinum crucible, during some rather long series of fusions of rock powder with sodium carbonate. It must be premised that both crucibles were reserved for this operation, though occasionally they were used for the evaporation of the solution of alkali chlorides in the determination of potash and soda; this, however, would not noticeably affect their weights.

Since June 12, 1918 (when it was used for the first time), the palau crucible has been used 47 times for a sodium carbonate fusion. Since that date the crucible has not been scrubbed with sand, nor was it used for the pyrosulfate fusion or other ignition that might presumably affect its weight. The evaporations for alkali chlorides for which it was used were made at 100°, and

were followed by a very gentle heating after dryness to drive off the ammonium chloride. It would thus appear that the sodium carbonate fusion was the only factor that might lead to loss in weight, whether through the temperature of ignition or through the action of the carbonate. The same balance and the same weights were used throughout the series.

On June 12, 1918, the weight of the palau crucible was 32.0712 g., and the weight diminished steadily and with great regularity through the series of 47 carbonate fusions until the last weighing, on November 8, 1920, when it was 32.0613 g. The difference is 0.0099 g., giving an average loss in weight for each fusion of 0.00021 g., that is, about 0.2 mg.

For comparison with this there was taken a series of 21 weighings of an iridium-platinum crucible (percentage of iridium unknown). The first weighing of the series was made just after the crucible had been scrubbed with sea sand (Dec. 5, 1914), and the last when another set of weights was put into use (Sept. 9, 1916). This crucible, likewise, was reserved for the sodium carbonate fusions, and only occasionally for the evaporation of the alkali chlorides. The initial weight of this crucible was 30.1493 g., and the final, after a series of steadily diminishing weights, was 30.0656 g. This gives a total loss in weight of 0.0099 g. (by coincidence identical with the other), and an average loss in weight of 0.00047 g. Thus the iridium-platinum crucible showed an average loss, due to the fusions, rather more than twice that of the palau. It is well known that crucibles made of platinum containing iridium lose weight very noticeably on ignition, which is commonly ascribed to volatization of iridium, and this factor would seem to have had influence here.

No estimate was made of the average loss in weight suffered by pure platinum crucibles which had been in use before the iridium-platinum one, as my notes showed that they had been used occasionally for the fusion with potassium pyrosulfate, which would cause a serious and rather irregular loss (which may be as much as 5 mg.). For the same reason a long series of data on my crucibles that had been used in my own laboratory at Locust, New Jersey, from 1896 to 1912 was rejected.

Conclusions.—The cold cake from the sodium carbonate fusion is freed very readily and completely from a palau crucible, much more readily than from one of iridium-platinum, and still more so than from one of pure platinum. The average loss in weight after each sodium carbonate fusion for the palau crucible investigated was about 0.2 mg., and that of an iridium-platinum crucible was about 0.5 mg. The greater average loss of the latter may be ascribed, in part, to volatilization of iridium.

GENETICS.—*Linkage between brachytic culms and pericarp and cob color in maize.*[1] J. H. KEMPTON, Bureau of Plant Industry, U. S. Department of Agriculture. (Communicated by G. N. Collins).

Characters which tend to be inherited together are said to be linked, on the assumption that the genes for such characters are arranged in a linear series on the same chromosome. The agreement between the number of groups of linked characters and the number of chromosomes and the linear arrangement of the genes has been demonstrated genetically with remarkable detail for the fruit fly (*Drosophila melanogaster*) by Morgan and his coworkers and for other species of *Drosophila* by Metz.

While it seems almost certain that groups of linked characters corresponding to the number of chromosomes will be found also in plants, nevertheless, up to the present time this has not been demonstrated.

In several respects plants would seem to offer better opportunities than animals for studies of this kind, and among plants *Zea mays* has many advantages. In the number and frequency of variations alone *Zea* probably exceeds *Drosophila*, while in the physiological importance of the structures involved it far surpasses any animal organism where much less fundamental changes are almost certain to be fatal. The number of chromosomes, however, is relatively large, necessitating the intensive study of many characters, but with each succeeding linkage or demonstrated independence progress becomes more rapid.

[1] Received November 11, 1920.

Since the first pair of linked characters was found in maize in 1911, six others have been reported, the present pair making the eighth.

The linked characters reported thus far are listed below:

Characters	Factor symbols	Per cent crossovers	Reported by
Waxy endosperm	Xx		Bregger, 1918
Aleurone color	Cc	25	Collins and Kempton, 1911
Endosperm color	[b]	25	Kempton, 1917
Albino seedlings	[b]		
Golden leaf color	Gg		
Aleurone color	Rr	23	Lindstrom, 1918
Golden leaf color	Gg		
Yellow seedling	Ll	19	Lindstrom, 1918
Yellow seedling	Ll		
Aleurone color	Rr	0	Lindstrom, 1918
Sweet endosperm	Ss		
Podded seeds	Tt	18.5	Jones, 1919
Spotted aleurone	Ss		
Aleurone color	Rr	12.5	Kempton, 1919[a]
Brachytic culms	Br br		
Pericarp and cob color	[b]	35+	Reported here

[a] Emerson (1918) explains this relationship in another way.
[b] Actual factors involved not identified.

Brachytic culms, a variation in which the internodes are very much shortened, made its appearance in a second generation hybrid and thus far behaves as a unit character in crosses with the normal form. (Kempton 1920.) Unlike Emerson's extreme dwarf anther ear (Emerson 1912) the brachytic variation is not readily recognized in the seedling stage but is conspicuous before the tassel appears.

This variation has been crossed with several others in an effort to determine its relationships. Many of these crosses have been carried through the second generation and most of them indicate little if any association of the brachytic character with the other variations. In some of the crosses the results were conflicting and further analysis is necessary. One relationship, however, seems certain, since it is corroborated in three unrelated crosses. This is the association of brachytic culms with cob and pericarp color.

Through the courtesy of Prof. R. A. Emerson we were supplied with a sample of his liguleless leaf variation (Emerson 1912). This variation is one in which the line of demarcation between the sheath and the blade is lost and the leaves possess neither ligules nor auricles. In the strain supplied us the color of the pericarp and cob was red. This liguleless leaf variation was crossed with a strain of brachytic culms which had a white pericarp and cob.

The plants of the first generation were all normal in stature with red cobs, and pericarps and the leaves all had the normal ligules. Nine of these first generation plants were self-pollinated and separate progenies were grown from each of the resulting ears.

With respect to the pericarp and cob colors only two classes of plants were obtained in the second generation, namely, those with a red cob and pericarp and those with a white cob and pericarp. This is in accord with the results of Emerson, 1911.

The other two characters involved (brachytic culms and liguleless leaves) occurred in all possible combinations with each other and with the cob and pericarp colors. Since the color of the cob and that of the pericarp were always alike on any given plant, it has been found convenient to refer to this character simply as the color of the cob.

The distribution of the plants of the nine progenies for color of the cob and character of the culm is shown in table 1.

In each case the red cob color is found to be associated with normal stature which is the parental combination. Although the degree of association varies, the coefficient of association of 0.463 ± 0.038 for the entire group indicates a crossing-over percentage of 35.5.

Practically the same percentage of "crossovers" was obtained from a cross between a Maryland red dent variety of normal stature with the white-cobbed strain of the brachytic variation. The first generation plants of this cross, as in the liguleless-brachytic cross, were all normal in stature with red cobs and pericarps.

TABLE 1

DISTRIBUTION OF PLANTS WITH RESPECT TO COB COLOR AND THE CHARACTER OF THE CULM IN THE SECOND GENERATION OF A HYBRID BETWEEN LIGULELESS LEAVES AND BRACHYTIC CULMS (PARENTAL COMBINATION RED COB NORMAL STATURE)

Progeny	Red cob Normal stature	Red cob Brachytic stature	White cob Normal stature	White cob Brachytic	Total	Per cent White cob	Per cent Brachytic	Q	Per cent Crossover
L1	215	46	60	36	357	26.8 ± 1.6	23.0 ± 1.5	0.474 ± 0.072	35.5
L2	90	22	21	13	146	23.3 ± 2.4	24.0 ± 2.4	0.434 ± 0.119	36.7
L3	128	26	43	18	215	28.4 ± 2.1	20.5 ± 1.9	0.12 ± 0.118	46.4
L4	53	4	17	7	81	29.6 ± 3.4	13.6 ± 2.6	0.69 ± 0.103	27.9
L5	85	14	27	21	147	32.6 ± 2.5	23.8 ± 2.4	0.65 ± 0.085	29.4
L6	83	13	21	9	126	23.8 ± 2.6	17.5 ± 2.0	0.464 ± 0.123	35.9
L7	47	7	15	9	78	30.7 ± 3.5	20.5 ± 3.0	0.605 ± 0.123	31.3
L8	54	8	25	7	94	34.0 ± 3.3	15.9 ± 2.4	0.308 ± 0.162	40.6
L9	69	15	22	9	115	27.0 ± 2.8	20.9 ± 2.3	0.305 ± 0.138	40.7
Total	824	155	251	129	1357	28.0 ± 0.08	20.9 ± 0.07	0.463 ± 0.038	35.5

In the second generation it was found that the pericarps and cob colors again behaved as a unit, only plants with red cobs and red pericarps and plants with white cobs and white pericarps being found.

The distribution of the plants with respect to the color of the cob and the character of the culm is shown in table 2.

Although, as in the first instance, the progenies vary in the degree of relationship, the per cent of "crossovers" for the entire group is remarkably close to that of the liguleless × brachytic hybrid.

A third cross involving brachytic culms and cob color has also been carried through the second generation. In this cross the parent of normal stature was a segregate from a cross between *Zea tunicata* and *Z. ramosa* and had a red cob but a white pericarp, while the brachytic parent, as in the other crosses, had both cob and pericarp white.

TABLE 2

DISTRIBUTION OF PLANTS WITH RESPECT TO COB COLOR AND THE CHARACTER OF THE CULM IN THE SECOND GENERATION OF A HYBRID BETWEEN A MARYLAND DENT VARIETY OF NORMAL STATURE AND RED COB AND THE BRACHYTIC VARIATION WITH WHITE COB

Progeny	Red cob Normal stature	White cob Normal stature	Red cob Brachytic	White cob Brachytic	Total	Per cent White cob	Per cent Brachytic	Q	Per cent Crossover
Ah487L 1	206	68	59	32	365	24.9 ± 1.5	27.4 ± 1.6	0.243 ± 0.087	42.6
L 2	60	17	15	7	99	24.3 ± 2.9	22.2 ± 2.8	0.246 ± 0.165	42.4
L 3	46	9	5	9	69	26.1 ± 3.6	20.3 ± 3.3	0.805 ± 0.076	23.1
L 4	28	16	6	11	61	44.3 ± 4.3	27.8 ± 3.9	0.525 ± 0.10	34.0
L 5	31	13	9	10	63	36.5 ± 4.1	30.1 ± 4.0	0.453 ± 0.17	36.3
L 6	41	14	9	9	73	31.5 ± 3.7	24.6 ± 3.5	0.491 ± 0.15	35.0
L 7	36	8	5	4	53	22.6 ± 3.9	17.0 ± 3.5	0.566 ± 0.21	32.7
L 8	42	19	10	9	80	35.0 ± 3.6	23.7 ± 3.2	0.331 ± 0.17	39.9
L 9	71	14	9	14	108	25.9 ± 2.9	21.3 ± 2.6	0.765 ± 0.07	25.0
L10	55	13	9	8	85	24.7 ± 3.2	20.0 ± 2.9	0.580 ± 0.13	32.1
L11	70	19	9	6	104	24.0 ± 2.9	14.4 ± 2.4	0.422 ± 0.14	37.1
Total	686	210	145	119	1160	28.4 ± 0.09	21.9 ± 0.08	0.456 ± 0.041	36.1

TABLE 3

DISTRIBUTION OF PLANTS WITH RESPECT TO COB COLOR AND THE CHARACTERS OF THE CULM IN THE SECOND GENERATION OF A HYBRID BETWEEN A TUNICATA × RAMOSA SEGREGATE WITH RED COBS AND NORMAL STATURE AND THE BRACHYTIC VARIATION WITH WHITE COB (PARENTAL COMBINATION RED COB NORMAL STATURE)

Progeny	Red cob Normal stature	White cob Normal stature	Red cob Brachytic stature	White cob Brachytic	Total	Per cent Brachytic	Per cent White cob	Q	Crossover
L1	208	63	42	36	349	22.4 ± 1.6	28.4 ± 1.6	0.478 ± 0.072	35.5
L16	72	31	17	8	128	19.5 ± 2.3	31.2 ± 2.8	0.044 ± 1.53	48.8
L17	67	19	25	20	131	34.3 ± 2.8	29.8 ± 2.7	0.476 ± 1.20	35.1
L19	48	4	24	9	85	38.8 ± 3.6	15.3 ± 2.6	0.637 ± 1.15	29.6
Total	395	117	108	73	693	26.1 ± 1.1	27.4 ± 1.1	0.39 ± 0.056	38.1

TABLE 4

DISTRIBUTION OF PLANTS WITH RESPECT TO THE CHARACTER OF THE LEAVES AND CULMS IN THE SECOND GENERATION OF A HYBRID BETWEEN LIGULELESS LEAF AND BRACHYTIC CULM (PARENTAL COMBINATION LIGULELESS NORMAL STATURE)

Progeny	Ligule Normal stature	Ligule Brachytic stature	Liguleless Normal stature	Liguleless Brachytic stature	Total	Per cent Liguleless	Per cent Brachytic	Q	Per cent Crossover
Ah489L1	216	71	61	20	368	22.0 ± 1.5	24.7 ± 1.5	0.305 ± 0.097	40.5
L2	90	33	33	5	161	23.6 ± 2.3	23.6 ± 2.3	0.413 ± 0.142	37.1
L3	128	44	48	13	233	26.1 ± 1.9	24.5 ± 1.9	0.119 ± 0.122	46.3
L4	64	12	24	7	107	30.9 ± 3.0	17.3 ± 2.5	—0.217[a] ± 0.161	56.6
L5	84	31	32	4	151	23.8 ± 2.3	23.2 ± 2.3	0.494 ± 0.138	34.5
L6	83	24	36	1	144	17.4 ± 2.2	25.7 ± 2.5	0.825 ± 0.094	20.7
L7	63	20	30	5	118	21.2 ± 2.6	29.7 ± 2.8	0.311 ± 0.172	40.3
L8	71	20	25	7	123	22.0 ± 2.6	26.0 ± 2.7	0.003 ± 0.161	50.0
L9	82	31	23	5	141	25.5 ± 2.5	19.8 ± 2.3	0.27 ± 0.160	41.6
Total	881	286	312	67	1549	24.5 ± 0.07	22.8 ± 0.08	0.204 ± 0.049	43.7

[a] The minus sign indicates that the coefficient of association is between the character combinations as they did not occur in the parents.

TABLE 5

DISTRIBUTION OF SAME PLANTS AS IN TABLE 4 WITH RESPECT TO THE COLOR OF THE COB AND THE CHARACTER OF THE LEAF (PARENTAL COMBINATIONS RED COB LIGULELESS AND WHITE COB LIGULE)

Progeny	Red cob Ligule	Red cob Liguleless	White cob Ligule	White cob Liguleless	Total Plants	Per cent White cob	Per cent Liguleless	Q	Per cent Crossovers
L1	205	56	73	22	356	26.7 ± 1.6	21.9 ± 1.5	—0.049[a] ± 0.092	51.3
L2	85	27	28	6	146	23.3 ± 2.4	22.6 ± 2.3	0.194 ± 0.157	43.9
L3	112	42	49	12	215	28.4 ± 2.1	25.1 ± 2.0	0.209 ± 0.130	43.2
L4	42	15	18	6	81	29.6 ± 3.4	26.0 ± 3.3	0.034 ± 0.212	48.9
L5	68	31	42	6	147	30.6 ± 2.5	25.1 ± 2.4	0.457 ± 0.145	35.8
L6	68	28	27	3	126	23.8 ± 2.5	24.6 ± 2.6	0.599 ± 0.138	30.8
L7	43	11	20	4	78	30.7 ± 3.5	19.2 ± 3.0	0.123 ± 0.212	46.1
L8	47	15	27	5	94	34.1 ± 3.2	21.3 ± 2.8	0.688 ± 0.146	27.3
L9	73	11	23	8	115	27.0 ± 2.6	16.5 ± 2.2	—0.393[a] ± 0.138	62.3
Total	743	236	307	72	1358	27.9 ± 0.8	22.7 ± 0.8	—0.151 ± 0.055	45.3

[a] The minus sign indicates that the coefficient of association is between the character combinations as they did not occur in the parents.

In the first generation the plants showed a segregation with respect to cob color, half the plants having red, the other half white cobs, indicating that the red-cobbed parent was heterozygous for cob color. Four self-pollinated ears with red cobs were obtained and progenies of these had approximately three plants with red cobs to one with white. These four progenies are fairly uniform with respect to the Mendelian ratios. The distribution of the plants with respect to cob color and culm characteristics is shown in table 3. The percentage of "crossovers" varies from 29.6 to 48.8 with an average for the group of 38.1. This percentage, though somewhat larger than in the other two hybrids, does not vary from them by an amount too large to be ascribed to chance.

It may be concluded, therefore, that the genes for cob color and stature are located in the same chromosome and rather widely separated, the distance being between 31 and 43 units.

The nine second-generation progenies of the liguleless × brachytic cross afford also an opportunity to measure the interrelations of the leaf and culm characters. These nine progenies vary in the degree of relationship between the brachytic stature and the liguleless leaf. In all but one progeny the correlations were between normal stature and liguleless leaf which is the parental combination. The classes of plants are shown in table 4. In the one exception the probable error does not preclude placing it with the others since the deviation from the mean of the group is but 2.5 times the error.

The correlation of 0.204 ± 0.049 for the entire group indicates a rather loose linkage, the percentage of crossovers being 43.7. The deviation from independence or 50 per cent crossing over is slightly over 4 times the error. It would seem, therefore, that if the genes for these characters are located on the same chromosome they are widely separated.

If it is held that the genes for the brachytic and liguleless characters are located in the same chromosome 44 units apart it then follows from the relation of brachytic culms to cob color that the gene for liguleless leaves must be either 8 or 80 units from that for cob color. The classes of plants are shown in

table 5. It will be seen from this table that the relation of cob color to liguleless leaf is very erratic with a mean crossover percentage of 45.3, which is practically independence. It is possible, therefore, that the slight relationship of the leaf and culm characters indicated in table 4 is but the result of chance and that the genes for these two characters are borne in reality by separate chromosomes, though this point cannot be determined definitely until some character is found that is independent of cob color and measurably correlated with brachytic culms.

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PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY OF WASHINGTON

833RD MEETING

The 833rd meeting was held at the Cosmos Club, March 27, 1920. President SOSMAN presided and about 75 persons were present. The speaker of the evening was Dr. SAUL DUSHMAN, of the General Electric Co., who presented a paper on *Methods for the production and measurement of extremely low pressures.*

The pressures dealt with under this heading range from one millionth of an atmosphere (1 bar) to pressures lower than 10^{-4} bar. For the proper operation of a number of hot cathode devices, it is absolutely necessary to obtain pressures which are well below 10^{-2} bar. The methods used for the production of high vacua may be classified for convenience under three headings: (1) *Mechanical pumps*, of which the rotary mercury or oil pump and Gaede molecular pump are typical illustrations. With the former, pressures as low as 10^{-1} bar can be attained, while the Gaede molecular pump is capable of producing vacua as high as 10^{-4} bar. (2) *Mercury vapor pumps.* The Gaede diffusion pump and Langmuir condensation pumps are both capable of producing extremely high vacua. The latter is, however, much more rapid in its operation. (3) *Physico-chemical methods.* By means of charcoal immersed in liquid air it is possible to obtain extremely low pressures in devices in which gas is being evolved continually either from metal parts or glass walls. The volatilization of calcium has been suggested by Soddy as another method for producing low pressures in sealed-off tubes.

In the actual exhaust operations, it is of importance to consider the resistance to flow of glass tubes, as well as the speed of the pump. The laws of flow of gases at low pressures have been studied by Smoluchowski and Knudsen and it is possible by means of the formulae derived by the latter to calculate the effect of glass tubing of given dimensions on the speed of exhaustion.

Methods of measuring low pressures.—The McLeod gauge is the simplest but is not always applicable and is not very sensitive for pressures below 10^{-1} bar. Pirani and Hale have developed an electrical resistance method which is capable of measuring pressures as low as 10^{-2} bar. The molecular gauge devised by Langmuir is sensitive to 10^{-4} bar, but is difficult to construct. Knudsen developed a radiometric type of gauge and various modifications of it have been designed by which pressures as low as 10^{-5} bar can be measured. The simplest method of measuring low pressures is the ionization gauge. This is very convenient for measuring the pressure in sealed-off hot cathode devices and incandescent lamps.

The paper was illustrated by lantern slides, and was discussed by Messrs. BURKA, FOOTE, SOSMAN, MCKEEHAN, WHITE, STIMSON, MERWIN, KANOLT, and WENNER.

Informal presentations: At the request of Mr. C. A. BRIGGS, Mr. W. J. HUMPHREYS spoke briefly concerning the aurora of March 22, 1920.

Mr. G. F. HULL described an unusual aurora which he had witnessed.

834TH MEETING

The 834th meeting was held at the Cosmos Club April 10, 1920, with 50 persons present, and Vice-President CRITTENDEN in the chair. The program was as follows:

H. C. DICKINSON: *Physical laboratory methods applied to aircraft engines at high altitudes.*

A special laboratory equipped for making precise determinations of the various factors in the performance of aircraft engines under all conditions of operation was developed at the Bureau of Standards during the war. The methods of measuring power, heat and temperature distribution, pressure, densities, etc., are distinctly those of the physical laboratory. In addition to studies of engine performance, parallel investigations have been made of the problems of ignition, carburetion, cooling, lubrication, etc., for which special laboratory equipment has been provided.

In connection with these researches, a number of special instruments have been designed. These include a balanced-diaphragm pressure indicator for recording engine cylinder pressures accurately by a point to point method; an instrument for measuring the clearance volume in engine cylinders; and a device for measuring conveniently the maximum cylinder pressure.

The paper was illustrated by lantern slides, and was discussed by Mr. BUCKINGHAM.

M. D. HERSEY: *Old and new problems of aeronautic instruments.*

The speaker called attention to charts and instruments which had accumulated on this subject since the occasion of his last paper before the Society, which was the year before the war.

The charts were as follows:

1. Rejection limits for aviation altimeters.
2. Temperature lag of aneroids.
3. The two temperature effects on instruments with elastic action.
4. Theory of ground speed indicator.
5. Results of Venturi tube experiments in air and water.
6. Results of Venturi tube experiments in vacuum wind tunnel and on an airplane.
7. Dimensional theory of compass damping.
8. List of new problems awaiting solution as follows:
   - (*a*) Stabilizer for ground speed indicators.
   - (*b*) Air speed indicator for dirigibles.
   - (*c*) True altitude meter.
   - (*d*) Gyroscopic or double pivot compass.
   - (*e*) Temperature compensated diaphragms with small elastic lag.

The instruments shown were as follows:

1. Vibration stand for instruments, together with Dr. Dickinson's vibrometer.
2. Precision altimeter.
3. Group showing evolution of rate-of-climb indicators.
4. Group of various Pitot and Venturi tubes.
5. Working model of Franklin stabilizer.
6. Air damped compass for dirigibles.
7. Working model of ground speed indicator.
8. Combination inclinometer, banking indicator and gyroscopic turn indicator in operation.

Lantern slides were also shown as follows:

1. Certificates showing test results on aneroid barometers tested at the government laboratories of England, France, Germany and the United States.
2. A group of curves showing errors of aneroids.
3. Diaphragm investigation exhibit.
4. Dummy observer utilizing moving picture film for instrument observations in flight (3 views).

The paper was discussed by Messrs. CROOK and TUCKERMAN.

S. J. MAUCHLY, *Recording Secretary.*

ARCHAEOLOGICAL SOCIETY

The 19th annual meeting of the Washington Society of the Archaeological Institute of America was held at the home of Mr. ROBERT LANSING on Saturday, November 13, 1920.

Sir WILLIAM RAMSAY gave an illustrated lecture on *An archaeological retrospect and prospect in Anatolia.*

The following officers were elected for the year 1921: *President,* ROBERT LANSING; *Vice-Presidents,* ROBERT M. THOMPSON, Miss MABEL BOARDMAN, HENRY WHITE and Mrs. H. F. DIMOCK; *Secretary,* MITCHELL CARROLL; *Associate Secretary,* Miss HELEN WRIGHT; *Treasurer,* JOHN B. LARNER; *Councillors,* ROBERT LANSING (ex-officio), CHARLES HENRY BUTLER, MITCHELL CARROLL (ex-officio), WILLIAM MILLER COLLIER, F. WARD DENYS, WILLIAM P. ENO, WILLIAM H. HOLMES (ex-officio), JOHN B. LARNER, H. B. F. MACFARLAND, JAMES PARMELEE, J. TOWNSEND RUSSELL and ROBERT M. THOMPSON; *Executive committee,* the above named officers and ALBERT DOUGLAS, Miss AMARYLLIS GILLETT, GILBERT GROSVENOR, MARTIN A. KNAPP, CHARLES COLFAX LONG and GEORGE OAKLEY TOTTEN, JR.

MITCHELL CARROLL, *Secretary*

SCIENTIFIC NOTES AND NEWS.

A luncheon was given in the Smithsonian Building on November 16, in honor of the seventieth birthday of Dr. J. WALTER FEWKES, chief of the Bureau of American Ethnology.

Dr. J. PAUL GOODE, professor of geography at the University of Chicago, gave an address before the General Staff at the Army War College on November 12, on *The geographic and economic foundations of the world war.*

Mr. RALPH W. HOWELL, geologist with the U. S. Geological Survey, was killed by native raiders in Beluchistan in the latter part of November, 1920. He was engaged at the time in oil exploratory work for Pearson & Son of London, and was working near the Beluchistan-Punjab border in an area that had been considered safe from bandits. Mr. Howell was born in 1886, and had been a member of the Survey staff since 1913. He was granted leave of absence from the Survey in October 1919 to engage in private work. He was a member of the Geological Society.

A series of lectures on *Heaviside's operational methods as applied to physical problems* is being given at the Bureau of Standards by Professor A. PRESS.

Rear Admiral EDWARD R. STITT, of the Naval Medical Corps, has been appointed surgeon general of the Navy and chief of the bureau of medicine and surgery, Navy Department, succeeding Rear Admiral W. C. BRAISTED, who has been surgeon general of the Navy since 1914, and who went on the retired list in November.

Dr. T. WAYLAND VAUGHAN, geologist in charge of the Coastal Plain section of the U. S. Geological Survey, is on leave for several months to engage in private work in Mexico.

Prof. BAILEY WILLIS, formerly geologist on the U. S. Geological Survey, and now professor of geology at Leland Stanford Junior University, California, is spending several months in Washington.